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FORTRAN IV PROGRAM FOR COMPUTATION OF GROUP TABLES OF FINITE GROUPS — PROGRAM FOR SECOND GENERATION MACHINES

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16. Abstract

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FORTRAN IV PROGRAM FOR COMPUTATION OF GROUP TABLES OF FINITE

GROUPS - PROGRAM FOR SECOND GENERATION MACHINES

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SUMMARY

A FORTRAN program suitable for second generation machines has been written for machine computation of group tables of finite groups. The method depends on the fact that every finite group G, of order n, is isomorphic to some subgroup T_n of the symmetric group S_n. The procedure for using the program is as follows: After finding the T_n which is isomorphic to G, the user enters the elements of T_n into the program as input data. The group table for T_n is computed and printed. Using the isomorphism between T_n and G, the user then translates back to the elements of G. The group A_5, the even permutation subgroup of S_5, is shown as an example.

INTRODUCTION

In the past decade, there has been a greatly expanded interest in the application of group theory to physical problems. As a result, there arose a need for detailed information about fairly large finite groups. It was natural to apply computing machines to this problem and a large number of programs were written for proving theorems and algorithms about finite groups whose group tables were entered as input data (ref. 1).

Recently a further step was taken in the direction of automating computations involving finite groups when a FORTRAN program was written for the machine computation of group tables of finite groups (ref. 2). The method made use of the fact that every finite group of order n is isomorphic to some subgroup of the symmetric group S_n. In this program, it was only necessary to enter the elements of the group as input data and the group table was then computed and printed as output. The only knowledge of group theory required by the user was that which established the isomorphism between the group of interest and the appropriate subgroup of S_n. This isomorphism was needed because both the input data and the output are in the form of group elements of S_n.

The program was machine-dependent and was written for use on the NASA Lewis Research Center's IBM 360-67. In many laboratories, only second generation machines are available. In order to enable people limited to such facilities to use this method, the program from reference 2 has been adapted to the language acceptable to the IBM 7094.

The adaptation to 7094 machines requires changes in the details of the program that are not trivial. However, the overall procedure is the same. Therefore, detailed descriptions of the listing are still included in this report, but the reader is frequently referred to reference 2 for extensive explanations of the reasons for the procedure. As shown in the example, the output is not quite as compact as in reference 2.

DEFINITIONS AND CONVENTIONS

The basic idea behind the method is explained in reference 2. The symbol S_n designates the permutation group of n objects and is of order n factorial. The even permutation group of n objects A_n is a proper subgroup of S_n. The group elements are expressed as cycles, each of which is broken down to a product of transpositions in executing the group operations. The numbers between commas in a cycle are called units. The convention adopted herein for describing the effect of a cycle is that in which the units denote objects and each unit is moved to the location currently occupied by the unit to its left.

The term standard configuration (SC) is used to describe an arrangement in which the ith object is in the ith location for i = 1 to N where N is the number of objects and/or locations. When N = 3, for example, SC means

Location	1	2	3
Object	1	2	3

The usefulness of class algebra tables for breaking up the group tables of large groups was explained sufficiently in reference 2 and will not be repeated here.

It should be noted that the first row and column of the group tables will only appear as row or column headings.

PROGRAM DESCRIPTION
General Description

Before the input or the form of the output is selected, an isomorphism must be

established between the group of interest G and a subgroup T_n of S_n. Often, an iso-morphism can be found between G and a subgroup T_j, of some S_j, where $j < n$. It will clearly be advantageous to use as small a permutation group as can be thought of for this purpose. The isomorphism between G and T_j should first be duly recorded. Then the program is used to compute the group table for T_j. From this table and the recorded isomorphism between T_j and G, the group table for G is obtained.

The broad outlines of the program and even most of the details are the same as in reference 2. Nevertheless, many minor changes still appear throughout the main list-ing, and rather extensive changes are present in subroutine SQUEZ. Therefore, a de-tailed description of the program is included in this report.

The program computes a group table for elements of T_j which are read in as a series of column and a series of row operations in cycle notation. The usual convention is adopted in which a row operation refers to a group operation in the vertical heading to the left of a group table, whereas a column operation refers to a group element in the horizontal heading at the top of a group table. The general procedure consists of the following steps:

(1) A set of K column operations and L row operations is read into the program.

(2) Each of these operations is broken down into its equivalent sequence of trans-positions. Let the group operation P_{ij} represent the (group) product of the ith row operation R_i by the jth column operation C_j. Then P_{ij} will be stored as a long se-quence of transpositions.

(3) The SC is rearranged in accordance with the sequence of transpositions that represent P_{ij}.

(4) The rearrangement is examined and a single group operation that effects the same rearrangement of the SC is identified as the product $R_i * C_j$.

(5) This single group operation is entered in the ith row and j^{th} column of the group table array.

The entry in this location is to be interpreted as being the result of the group oper-ation C_j followed by the group operation R_i.

An outline of the program, broken down into sections which perform recognizable functions, follows. For more detailed descriptions, the listing in appendix A can be examined.

Block 1 - set up constants. - The constants used in the program are given literal names and are declared either INTEGER or LOGICAL in TYPE statements. All the subscripted variables are dimensioned and allotted storage locations by the use of DIMENSION statements. A DATA statement is used to give literal names to the vari-ables listed in the following table:

Variable	Literal name	Identification
(	LP	Left parenthesis
)	RP	Right parenthesis
,	CM	Comma
	BLK	Blank
E	IDNT	Identity element of group

Block 2 - read in DATA. - The data describing the group and the group operations are read into the program. The labels to be assigned to the objects and to the locations are read in from the list for IDENT which is limited to one card. It is read in with FORMAT(80A1), right shifted, and stored in INITAL(N) in the form bbbbbX, where b represents a 6-bit blank and X represents the 6-bit location in the 36-bit storage register (word) in which the integer from IDENT is stored.

In order to put the "words" in this form, use is made of four shift functions: IALS(N, NWORD) and IARS(N, NWORD), which cause the integer variable NWORD to be shifted N bits to the left and to the right, respectively, and ALS(N, WORD) and ARS(N, WORD), which cause the real variable WORD to be shifted N bits to the left and to the right, respectively. (The latter two functions are in subroutine SQUEZ, which is called in block 2, but which is described in a later section.)

All of these functions are standard on the IBM 7094. The machine at Lewis Research Center has these functions in its function library, and they can be called directly. For those users who do not have direct access to these functions, a map listing for all four is provided in appendix B.

Description of Input

The input cards are read in the following order:

First card   TITLE   one card with FORMAT(80A1)

Second card   IDENT   one card with FORMAT(80A1)

Note that the input for IDENT must be long enough to include the maximum number of objects to be moved in any group operation. Thus, the list for IDENT must be of the form $(A_1, A_2, \ldots, A_j)$ where j is the subscript of S_j and A_i is any alphanumeric symbol.

The next set of cards contains the ACROSS (column) operations. There can be as many as four cards with FORMAT(80A1), and each operation is followed by a period.

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A blank card follows the preceding set. It is needed to signal the end of the ACROSS input.

The next set contains the DOWN (row) operations. There can be as many as four cards with FORMAT(80A1), and again each operation is followed by a period.

A blank card follows the preceding set, signalling the end of the DOWN input.

The input for both ACROSS and DOWN operations is in cycle notation.

Several error checks are run on IDENT. These include checking the maximum number of nonblank units (which is six in this version of the program), the presence of blank spaces on the card, and the illegal use of parentheses.

The group elements themselves are read in from the list for INPUT(J, K), which is also read in with FORMAT(80A1). The complete set of column operations is read first. Then the complete set of row operations is read. Each of these sets is limited to four cards and is followed by a blank card.

The example which follows is the class algebra block $K_5 * K_4$ of group A_5. The symbol K_4 represents the class of 20 group elements expressible as three unit cycles, while K_5 is the class of 15 group elements expressible as products of two independent transpositions. (See ref. 2 for further details.)

```
K5*K4
(1,2,3,4,5)
(1,2,3).(2,3,4).(1,3,4).(1,2,4).(1,2,5).(1,3,5).(2,3,5).(1,4,5).(2,4,5).(3,4,5).
(3,2,1).(4,3,2).(4,3,1).(4,2,1).(5,2,1).(5,3,1).(5,3,2).(5,4,1).(5,4,2).(5,4,3).
Card 5 is blank
(1,2)(3,4).(1,3)(2,4).(1,4)(2,3).(1,2)(3,5).(1,3)(2,5).(1,5)(2,3).(1,2)(4,5).
(1,4)(2,5).(1,5)(2,4).(1,3)(4,5).(1,4)(3,5).(1,5)(3,4).(2,3)(4,5).(2,4)(3,5).
(2,5)(3,4).
Card 9 is blank
```

Cards 3 and 4 are ACROSS (column) operations and cards 6, 7, and 8 are DOWN (row) operations.

<u>Block 3 - store each group operation as product of transpositions.</u> - In this block, each group operation is decomposed into its equivalent product of transpositions and then stored in PAIRS(I, NOP, K) (see appendix A). The third subscript K is 1 or 2 according to whether the operation is a column or row operation, respectively. Thus, an entry in PAIRS(I, NOP, K) is the Ith unit of the group element in the NOP[th] column (K=1) or NOP[th] row (K=2). Note that the four shift functions described in block 2 are used here, also.

The example used herein is the group product of (1, 3), (2, 4), and (5, 2, 1). This is an entry under (521) and to the right of (1, 3)(2, 4) in the $K_5 * K_4$ class product of A_5 (see ref. 2 and the last class product block in appendix C). The input for this block (which

was shown in the preceding section) shows that the element (521) was the 15th ACROSS (column) operation and therefore corresponds to $K = 1$, NOP $= 15$. Before being stored in a PAIRS array, the element is considered to be of the form (52)(21). Therefore the contents of {PAIRS(-, 15, 1)} is [5221]. The element (1, 3)(2, 4) is the 2nd DOWN (row) element; and it, therefore, corresponds to $K = 2$, NOP $= 2$. The contents of the four registers which constitute the complete {PAIRS(-, 2, 2)} array are [1324].

Block 4 - set up arrays in standard configuration. - In this block, a number of standard configurations are set up. If N_C and N_R are the total number of column and row operations, respectively, then $N_C \times N_R$ SC's are set up. A given SC is set up by storing the quantity bbbbbI in location ANS(I, I1, I2) (see listing in appendix A). For a fixed I1 and I2, the complete set of ANS(I, I1, I2) over the full range of I takes on the form of an SC. (See example in block 5.) Note that the second and third subscripts of ANS refer to column and row operations, respectively. On the other hand, a given PAIRS array describes either a column or a row operation, but never mixes these types.

Block 5 - perform group multiplication. - In this block, the detailed operations for all the group products, $P_{I2, I1}$ (operation I2 $*$ operation I1) are actually performed. The method used is to transpose, successively, units from the SC of ANS(-, I1, I2) in accordance with the indicated operation of PAIRS(-, I1, 1) followed by the operation of PAIRS(-, I2, 2). The operations may be understood by following the procedure on a single complete ANS(-, I1, I2) array.

The storage location ascribed to ANS(J, I1, I2) is considered to be the Jth location of the SC. The quantity stored in ANS(J, I1, I2) is considered to be the "thing" which moved to the Jth location as a result of the operation (operation I2 $*$ operation I1) on the SC. Schematically, upon entering block 5, the {ANS(-, I1, I2)} array is in the SC. Thus, for A_5, {ANS(-, I1, I2)} = [12345].

Continuing with the example of (13)(24)(521), when $K = 1$, $I1 = 15$, and when $K = 2$, $I2 = 2$. Therefore, {ANS(-, I1, I2)} = {ANS(-, 15, 2)}. The first rearrangement of the SC of this ANS array is the one effected by {PAIRS(-, 15, 1)}. After being operated on by {PAIRS(-, 15, 1)}, the {ANS(-, 15, 2)} array has the content [51342]. Following this rearrangement by {PAIRS(-, 15, 1)}, the I2th row operation {PAIRS(-, 2, 2)} is brought into play. The content of {ANS(-, 15, 2]} upon leaving block 5 and entering block 6 is thus [53124].

Block 6 - identification of the group product element. - In effect, the permuted stored values in each ANS array leaving block 5 are examined and a determination is made of the single group operation which would have permuted the SC to this ANS array in a single step. In block 6, this single operation is determined and stored in {OUT(-, I1, I2)}. Thus, an array {OUT(-, I1, I2)} represents the one group operation which has the same effect on the standard ANS array (SC) as does the product of the two operations (operation I2 $*$ operation I1).

In order to understand how the identification is made, reference may be made to the content of $\{ANS(-,15,2)\}$ upon entering block 6. The content of a given register of ANS is the same as the label of the <u>location</u> in the SC. Since, in the SC, the location and object have the same label, an examination of the content of a particular register in ANS provides (partial) information about the rearrangement of two objects. Referring to the ANS(-, 15, 2) array shows the content of register (1, 15, 2) to be the integer 5. This is taken to mean that the object 5 now occupies the position originally held by object 1. In cycle notation, this fact is indicated by placing a 1 to the left of 5; thus: 1, 5.

The next step is to examine the content of register 5, which is 4. Therefore, the next entry in the cycle has been found and the result is 1, 5, 4.

Since the content of register 5 was 4, the content of register 4 is examined next. This is found to be a 2, so that the cycle chain is now 1, 5, 4, 2 and register 2 is examined next. A 3 is found there and the chain is now complete: (1, 5, 4, 2, 3). The completion of the chain is tantamount to concluding that the operation (521) followed by the operation (13)(24) is equivalent to the single operation (15423). This cycle is the same group operation as (54231) which is the actual entry at the intersection of the column headed by (521) and the row headed by (13)(24) in the class product block $K_5 * K_4$ (see appendix C). As explained in reference 2 all equivalent cycles are printed in a unique manner in which the smallest integer in the cycle is at the extreme right.

<u>Block 7 - output and error messages</u>. - The group table is listed in this block. The error messages are also contained here.

<u>Subroutine SQUEZ</u>. - The usual manner of storing a single datum on the IBM 7094 is in a word of 36 bits. All the data in this program are integer type of such a size that only one byte in each word reserved for a datum is utilized. This results in a very inefficient use of storage. SQUEZ packs six pieces of data into one storage word. It also eliminates extraneous blanks.

The three variables from the main program to which SQUEZ is applied are: IDENT, INPUT, and OUT. It should be noted that the stored entries in OUT are of mixed form. At the time that SQUEZ is called, the punctuation marks in OUT are stored in the usual form Xbbbbb; whereas the numbers are stored in the right-shifted form bbbbbX. SQUEZ left-shifts either of such forms or any combination thereof until every byte in a given stored word contains useful information.

An example of the effect of SQUEZ can be seen by examining the form of the group element (1, 2, 3) before and after being "SQUEZed." If this element were part of an OUT array in the main program, then the seven words required to store it would have the following form:

(bbbbbbbbbbb1, bbbbbbbbbb2, bbbbbbbbbb3)bbbbb

Each grouping of six typed symbols shows a single stored word. Upon leaving SQUEZ, the group element is stored in only two words of the following form:

$$(1, 2, 3)\text{bbbbb}$$

A flowchart for this subroutine is given in figure 1.

SUMMARY OF PROCEDURE

A FORTRAN program for use on second generation (7094) computing machines has been written for the computation of group tables for finite groups. Use is made of the existence of an isomorphism between any finite group of order n and some subgroup T_n of the symmetric group S_n. The elements of T_n are entered as input data. The program then performs the group operations on these elements and identifies the products of these operations.

Each element entered as input data is expressed as a product of transpositions. The indicated interchanges for a group product of two such elements are then applied to a standard configuration. The resulting configuration is then identified with that configuration which a single group element would cause if applied to the standard configuration. This group element is called the product of the first two and entered in the row and column headed by the original two elements of T_n.

The complete table of A_5, the group of even permutations of five objects, is shown as a worked out example in appendix C.

Lewis Research Center,
    National Aeronautics and Space Administration,
        Cleveland, Ohio, March 11, 1970,
            129-04.

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APPENDIX A

PROGRAM LISTING

Main Program

```
C       BLCCK(1) SETS UP CONSTANTS

        CIMENSION INPUT(440,2), INITAL(6), IDENT(80), NPAIR(24,2), NOUT(24
       1,24), LINE(21), NIN(24,2), NINPUT(2), NOPA(2), KN(6)
        EQUIVALENCE(CHAR,CAR)
        INTEGER RP,CM,TEMP,BLK,CHAR,PER,PAIRS(18,24,2),ANS(6,24,24),OUT(15
       1,24,24),TITLE(80)
        LCGICAL COMMA,ONE
        DATA LP,RP,CM,BLK,PER,IDNT/1H(,1H),1H,,1H ,1H.,1HE/

C       BLCCK(2) READS IN DATA

1       READ (5,66) TITLE

C       TITLE IS NAME OF GROUP OR PART CF GROUP

        READ (5,66) IDENT

C       ICENT= THE NUMBERS OR LETTERS USED IN THE PERMUTATICN GROUP

        WRITE(6,80) TITLE
        WRITE(6,81) IDENT
        ILP=C
        IRP=C
        N=C
        CHAR=BLK

C       BLK IS STCREC IN OCTAL FORM AS 6C6060606060
C       A NCN-BLANK CHARACTER HAS THE FORM XX6060606060

        DC 5 I=1,8C
        TEMP=IDENT(I)
        IF (TEMP.EC.BLK) GO TO 5
        IF (TEMP.EC.LP) GO TO 2
        IF (TEMP.EC.RP) GO TO 3
        IF (TEMP.EC.CM) GO TO 4

C       SEE CCMMENTS AND SYMBOL LIST SECTION FOLLOWING FORMAT STATEMENTS

        CAR=CR(IALS(6,CHAR),IARS(30,TEMP))
        GC TC 5
2       ILP=ILP+1
        GC TC 5
3       IRP=IRP+1
4       N=N+1
        IF (N.GT.6) GO TO 61
        IF (CHAR.EC.BLK) GO TO 62
        INITAL(N)=CHAR


C       ENTRIES IN INITAL(N) ARE STORED AS BBBBBX
        CHAR=BLK
5       CCNTINUE
```

```
       IF (ILP.NE.1.OR.IRP.NE.1) GO TO 63
       ID=8C
       CALL SQUEZ (IDENT,ID)
       DO 8 K=1,2
       DO 7 I=1,5
       JS=(I-1)*8C+1
       JE=I*80
       READ (5,66) (INPUT(J,K),J=JS,JE)
       WRITE(6,90) (INPUT(J,K),J=JS,JE)
       DO 6 J=JS,JE
       IF (INPUT(J,K).NE.BLK) GO TO 7
6      CONTINUE

C      NINPUT(K) IS THE SL IN TYPE K INPUT.  IT  IS SET EC TO 80(NUMBER OF INPUT
C      CARCS OF TYPE K) +1.

       NINPUT(K)=JS
       GO TC 8
7      CONTINUE
8      CONTINUE

C      BLCCK(3) STCRES EACH OPERATICN IN PAIRS ARRAY AS A PRODUCT OF
C               TRANSPOSITIONS

       DO 19 K=1,2


C      NPAIR(I,K) IS THE TOTAL NUMBER OF UNITS USED TO REPRESENT THE ITH GROUP
C      OPERATION IN TYPE K WHEN THE OPERATION IS STORED AS A PRODUCT OF
C      TRANSPOSITICNS

       NPAIR(1,K)=C
       NCP=1
       IPRN=C
       CHAR=BLK
       II=C
       CNE=.TRUE.
       COMMA=.FALSE.
       IE=NINPUT(K)
       DO 16 I=1,IE
       TEMP=INPUT(I,K)
       IF (TEMP.EC.BLK) GO TO 16
       IF (TEMP.EC.LP) GO TO 9
       IF (TEMP.EC.RP) GO TC 10
       IF (TEMP.EC.CM) GO TC 11
       IF (TEMP.EC.PER) GO TO 14
       CAR=CR(IALS(6,CHAR),IARS(30,TEMP))
       GO TC 15
9      IPRN=IPRN+1
       CNE=.TRUE.
       IF (IPRN.LT.0.OR.IPRN.GT.1) GO TO 57
       GC TC 15
10     IPRN=IPRN-1
       IF (.NOT.CCMMA) GC TO 58
       COMMA=.FALSE.
       CNE=.TRUE.
       IF (IFRN.LT.C.OR.IPRN.GT.1) GO TC 57
       GC TC 12
11     COMMA=.TRUE.
12     NPAIR(NCP,K)=NPAIR(NOP,K)+1
       IF (NPAIR(NCP,K).GT.17) GO TC 59
       IF (CHAR.EC.BLK) GO TO 56
       IJ=NPAIR(NCP,K)
```

```
C       AN ENTRY IN PAIRS IS STORED IN FCRM BBBBBX

        PAIRS(IJ,NCP,K)=CHAR
        IF (CNE) GC TO 13
        NPAIR(NCP,K)=NPAIR(NCP,K)+1
        IJ=NPAIR(NCP,K)
        PAIRS(IJ,NCP,K)=CHAR
13      CHAR=BLK
        CNE=.FALSE.
        GC TC 15
14      NCP=NCP+1
        IF (NCP.GT.24) GC TO 60
        NPAIR(NCP,K)=0
15      II=II+1
        INPUT(II,K)=TEMP
16      CCNTINUE

C       HERE NINPUT(K) IS SET EQ 1 + SL OF TYPE K

        NINPUT(K)=II+1
        IF (INPUT(II,K).NE.PER) GO TC 17
        NCP=NCP-1
        GC TC 18
17      INPUT(II+1,K)=PER
18      IF (NPAIR(1,K).EQ.0) GO TO 1

C       NCPA(K) EQ THE TOTAL NUMBER CF GROUP OPERATIONS CF TYPE K
C       TYPE K MEANS K=1 FCR COLUMN CPERATIONS, K=2 FOR RCW OPERATIONS

        NCPA(K)=NCP
19      CONTINUE

C       BLCCK(4) SETS UP ANS ARRAY IN STANDARD FCRM OR CONFIGURATION

C       AN ENTRY IN ANS IS STORED AS BBBBBX

        NCP1=NOPA(1)
        NCP2=NOPA(2)
        CC 2C I1=1,NCP1
        CC 2C I2=1,NCP2
        CC 2C I=1,N
20      ANS(I,I1,I2)=INITAL(I)

C       BLCCK(5) PERFORMS THE PRODUCT OPERATIONS

        CC 27 I1=1,NCP1
        K1=NPAIR(I1,1)
        CC 27 I2=1,NCP2
        K2=NPAIR(I2,2)
        CC 23 I=1,K1,2
        J=K1-I+1
        J1=C
        J2=C
        CC 22 L=1,N
        IF (ANS(L,I1,I2).NE.PAIRS(J,I1,1)) GC TC 21
        J1=L
21      IF (ANS(L,I1,I2).NE.PAIRS(J-1,I1,1)) GO TC 22
        J2=L
22      CCNTINUE
        IF (J1.EC.C.OR.J2.EQ.0) GC TC 55
        ITMP=ANS(J1,I1,I2)
        ANS(J1,I1,I2)=ANS(J2,I1,I2)
        ANS(J2,I1,I2)=ITMP
23      CCNTINUE
```

11

```
            CC 26 I=1,K2,2
            J=K2-I+1
            J1=C
            J2=C
            CC 25 L=1,N
            IF (ANS(L,I1,I2).NE.PAIRS(J,I2,2)) GO TO 24
            J1=L
24          IF (ANS(L,I1,I2).NE.PAIRS(J-1,I2,2)) GO TO 25
            J2=L
25          CCNTINUE
            IF (J1.EC.C.CR.J2.EQ.0) GO TC 55
            ITMP=ANS(J1,I1,I2)
            ANS(J1,I1,I2)=ANS(J2,I1,I2)
            ANS(J2,I1,I2)=ITMP
26          CCNTINUE
27          CCNTINUE

C     BLCCK(6) ICENTIFIES THE SINGLE GROUP ELEMENT WHICH HAS THE SAME
C               EFFECT AS BLOCK(5)

C     MAX IS THE MAXIMUM NUMBER OF 36 BIT WORDS NEEDED TC CONTAIN THE LONGEST
C     GRCUP ELEMENT (INCLUDING PUNCTUATION) AFTER SQUEZ HAS BEEN APPLIED.

            MAX=C
            CC 38 I1=1,NOP1
            CC 38 I2=1,NCP2
            CUT(1,I1,I2)=LP
            CUT(2,I1,I2)=ANS(1,I1,I2)
            CUT(3,I1,I2)=CM

C     JRF IS A TEMPORARY STORAGE FCR SL IN THE I1,I2 CYCLE (SEE MAX). ITS
C     FINAL VALUE IS STORED IN NOUT(I1,I2).(SEE STATEMENTS 36 AND 37)

            JRF=C
            J=3
            K1=1
            CC 28 KK=1,N
28          KN(KK)=KK
            KN(1)=0
            CC 35 I=1,N
            CC 29 L=1,N
            K=L
            IF (CUT(J-1,I1,I2).EC.INITAL(K)) GO TO 3C
29          CCNTINUE
3C          IF (K.EC.K1) GO TO 31

C     KN(K) EC 0 MEANS THE CONTENT OF THE KTH LOCATION IN THE ANS ARRAY
C     HAS BEEN INCENTIFIED.

            KN(K)=0
            J=J+1
            CUT(J,I1,I2)=ANS(K,I1,I2)
            J=J+1
            OUT(J,I1,I2)=CM
            GC TC 35
31          KN(K)=0
            CC 32 KK=1,N
            K=KN(KK)
            IF (K.NE.0) GO TC 33
32          CCNTINUE
33          K1=K
            IF (CUT(J-2,I1,I2).NE.LP) GO TO 34
            IF (K.EC.0) GO TC 36
            CUT(J-1,I1,I2)=ANS(K,I1,I2)
            GC TC 35
```

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```
34       CLT(J,I1,I2)=RP
         JRP=J
         IF (K.EQ.0) GO TC 36
         J=J+1
         CLT(J,I1,I2)=LP
         J=J+1
         CUT(J,I1,I2)=ANS(K,I1,I2)
         J=J+1
         CLT(J,I1,I2)=CM
35       CCNTINUE
36       J=JRP
         IF (J.EQ.0) GO TC 37
         CALL SQUEZ (CUT(1,I1,I2),J)

C        NCLT(I1,I2) IS THE NUMBER OF SYMBOLS IN THE I1,I2 CYCLE (SEE MAX)
C        NCTE THAT AFTER RETURN FROM SQUEZ,JEQ THE TOTAL NUMBER OF WORDS REQUIRED
C        FCR CLT (-,I1,I2) ARRAY IN SQUEEZED FORM

37       NCLT(I1,I2)=J
         IF (J.LE.MAX) GO TO 38
         MAX=J
38       CCNTINUE

C        BLCCK(7) SETS UP THE OUTPUT FORMAT AND WRITES ERRCR MESSAGES

         CC 41 K=1,2

C        THE CC 41 LCCP DOES SOME LOGISTICAL PRELIMINARIES FCR THE ROW AND CCLUMN
C        HEACINGS CF THE  GROLP TABLE

         J=C
         J1=1
         IE=NINPUT(K)
         CC 4C I=1,IE
         IF (INPUT(I,K).NE.PER) GC TO 40

C        NIN(J),K) EC NUMBER OF WCRDS REQLIRED TO THE SL IN THE REPRESENTATICN OF
C        THE JTH GRCLP OPERATION OF TYPE K

         MX=I-J1+1
         CALL SQUEZ (INPUT(J1,K),MX)
         IF (MX.LE.MAX) GC TO 39
         MAX=MX
39       J1=MX+J1
         J=J+1
         NIN(J,K)=MX
40       CCNTINUE
41       CCNTINUE

C        TITLE ANC ICENT (SEE SYMBOL LIST) ARE WRITTEN BETWEEN HERE AND DO 54 STATE
C        MENT.

         NC=21
         MAX=MAX+1
         NLM=NC/MAX-1
         IF (NLM.LT.2) GO TO 64
         NM=(NCP1+NLM-1)/NUM
         WRITE (6,67) (IDENT(I),I=1,IC)
         WRITE (6,68) TITLE

C        SET LP FCR THE FIRST ROW (COLUMN HEACINGS) CF GRCLP TABLE

         K1=1
         DC 54 I=1,NM
```

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```
C        MAKE FIRST 21 WORDS BLANK. NOTE THAT EACH SQUEEZED WORD TAKES UP 6 SPACES
C        TC PRINT CLT

         CC 42 L=1,21
42       LINE(L)=BLK
         L1=MAX
         DC 44 J=1,NLM
         I1=(I-1)*NLM+J
         IF (I1.GT.NCP1) GO TC 45
         K2=MIN(I1,1)+K1-1
         CC 43 K=K1,K2
         L1=L1+1
43       LINE(L1)=INPUT(K,1)
         L1=(J+1)*MAX
44       K1=K2+1
45       WRITE (6,69) LINE

C        STATEMENT 45 HAS WRITTEN THE FIRST LINE CF THE TABLE (COLUMN HEADINGS)

C        THE MAIN BCCY OF THE TABLE IS WRITTEN LINE BY LINE BETWEEN THE STATEMENT
C        K3 EG 1 ANC STATEMENT NUMBER 52.

         K3=1
         CC 53 I2=1,NCP2
         L1=C

C        THE FIRST 21 WORCS BLANKED OLT (SEE COMMENT ON DO 42)

         CC 46 L=1,21
46       LINE(L)=BLK
         K4=MIN(I2,2)+K3-1
         CC 47 K=K3,K4
         L1=L1+1
47       LINE(L1)=INPUT(K,2)
         K3=K4+1
         L1=MAX
         CC 51 J=1,NLM
         I1=(I-1)*NLM+J
         IF (I1.GT.NCP1) GO TO 52
         K5=NCLT(I1,I2)
         IF (K5.EG.C) GO TO 49
         CC 48 K=1,K5
         L1=L1+1
48       LINE(L1)=CLT(K,I1,I2)
         GC TC 5C
49       L1=L1+1
         LINE(L1)=ICNT
5C       L1=(J+1)*MAX
51       CCNTINUE
52       WRITE (6,7C) LINE
53       CCNTINUE
54       CCNTINUE

C        WRITE STATEMENTS FOR ERRCR MESSAGES

         GC TC 1

55       WRITE (6,71) (IDENT(I),I=1,IC)
         WRITE(6,79) TITLE
         GC TC 1
56       WRITE (6,72)
         GC TC 1
57       WRITE (6,73)
         GC TC 1
```

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```
58      WRITE (6,74)
        GC TC 1
59      WRITE (6,75)
        GC TC 1
60      WRITE (6,76)
        GC TC 1
61      WRITE (6,77)
        GC TC 65
62      WRITE (6,72)
        GC TC 65
63      WRITE (6,73)
        GC TC 65
64      WRITE (6,78)
        GC TC 1
65      RETLRN


66      FCRMAT (80A1)
   67   FCRMAT(1HJ,10X,6HGROUP ,11A6)
   68   FCRMAT(1HJ,50X,3CA1)
   69   FCRMAT(1HL,21A6)
   7C   FCRMAT(1HJ,21A6)


C       FCRMATS FCR ERROR MESSAGES

   71   FCRMAT(1HJ,44HILLEGAL ELEMENT IN GROUP. IDENTITY GRCUP IS ,11A6)
   72   FCRMAT(1HJ,29HBLANK IS NCT A VALID ELEMENT.)
   73   FCRMAT(1HJ,22HILLEGAL USE OF PARENS.)
   74   FCRMAT(1HJ,14HILLEGAL GROUP.)
   75   FCRMAT(1HJ,34HTHE PAIRS ARRAY HAS BEEN EXCEEDED.)
   76   FCRMAT(1HJ,34HTOC MANY OPERATIONS.  LIMIT IS 24.)
   77   FCRMAT(1HJ,39HMORE THAN 6 ELEMENTS IN IDENTITY GRCLP.)
   78   FCRMAT(1HJ,45HNOT ENCUGH ROOM ON PRINT LINE TO PRIAT TABLE.)
   79   FCRMAT(1HJ,27HCHECK INPUT CARDS IN GROUP ,80A1)
   80   FCRMAT(1H1,80A1)
   81   FCRMAT(1HJ,80A1)
   9C   FCRMAT(1HJ,80A1)


C       THE FCLLCWING VARIABLES ARE SQEEZED  IDENT, INPUT, AND OUT.

C       STCRAGE FCR A WORD ON THE 7094 IS ALLOTTED 36 BITS. A WORD CAN BE 6
C       ALPHANUMERIC CHARACTERS LONG. EACH CHARACTER IS REPRESENTED BY ONE BYTE
C       (6 BITS LCNG).
C       A BYTE REPRESENTING A BLANK IS CODED IN CCTAL AS 6C
C       A FLLL BLANK WORC IS CODED IN OCTAL AS 6C6C60606C6C
C       A SINGLE NCN-BLANK CHARACTER IS STORED AS XX6060606060
C       IALS(6,CHAR) SHIFTS THE CHARACTERS IN THE WORD CHAR 6 BITS (OR ONE BYTE)
C       TC THE LEFT. THE LAST BYTE IS THEN REPLACED BY ZERCES(NOT BLANKS).A BLANK
C       WCRC CPERATEC ON BY IALS(6,CHAR) WOULD ASSLME THE FORM 606060606060.
C       IARS(30,TEMP) SHIFTS THE CHARACTERS IN TEMP 30 BITS(5 BYTES) TO THE RIGHT
C       AGAIN, THE 5 BYTES ARE REPLACED BY ZEROES THE FORM CF A NON-BLANK WORD
C       OPERATEC CN BY IARS (30,TEMP) WOULD BE CCOCC00000XX.
C       THE LCGICAL OR BETWEEN TWO QLANTITES A AND B STORES   1 IN A GIVEN BIT
C       LCCATION IF EITHER A OR B HAS  1  IN THAT LOCATICN O IS STORED IN A
C       GIVEN BIT LCCATICN ONLY IF BCTH A AND B HAVE O IN THAT LOCATION
C       THE EFFECT CF OR(IALS(6,CHAR) IARS(3C,TEMP) ON A NCN-BLANK TEMP OF THE
C       FCRM XX6C6C606060 IS TO CHANGE IT TO THE FORM 606C606060XX

        ENC
```

```
      SUBROUTINE SQUEZ(OUT,N)
      DIMENSION OUT(80)
      DATA MASK,BLANK,ZERO,BLANK1/
     *C770CC00C0C00,06C000CC00C00,C000CC0000000C,C6060606C6060 /
      IA=C
      IB=C
      TEMP=ZERC
      DO 1 I=1,N
      DO 1 J=1,6
      PART=ANC(MASK,ALS(6*(J-1),OUT(I)))
      IF(PART.EC.BLANK) GO TO 1
      IA=IA+1
      TEMP=CR(TEMP,ARS(6*(IA-1),PART))
      IF(IA.NE.6) GO TC 1
      IB=IB+1
      OUT(IB)=TEMP
      IA=C
      TEMP=ZERC
1     CONTINUE
      IF(IA.EC.C) GO TC 2
      IB=IB+1
      OUT(IB)=TEMP
      IA=IA+1
      DO 3 J=IA,6
3     OUT(IB)=CR(OUT(IB),ARS(6*(J-1),BLANK))
2     M=IB+1
      IF(M.GT.N) GO TO 4
      DO 5 J=M,N
5     OUT(J)=BLANK1
      N=IB
4     RETURN
      ENC
```

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APPENDIX B

MAP LISTING OF SHIFT ROUTINES

```
                    ENTRY    ALSF
                    ENTRY    ALS
                    ENTRY    ARSF
                    ENTRY    ARS
                    ENTRY    ALGRF
                    ENTRY    ALGR
                    ENTRY    ALGLF
                    ENTRY    ALGL
                    ENTRY    EXORF
                    ENTRY    EXOR
                    ENTRY    IEXOR
                    ENTRY    IALS
                    ENTRY    IALSF
                    ENTRY    IARS
                    ENTRY    IARSF
                    ENTRY    LRS
                    ENTRY    LRSF
                    ENTRY    LGR
                    ENTRY    LGRF
                    ENTRY    LLSF
                    ENTRY    LLS
                    ENTRY    LGL
                    ENTRY    LGLF
                    ENTRY    XLRSF
                    ENTRY    XLRS
                    ENTRY    XLLSF
                    ENTRY    XLLS
     IARS           NULL
     ARSF           NULL
     IARSF          NULL


     ARS            CLA*     3,4
                    STA      *+2
                    CAL*     4,4
                    ARS      **
                    XCL
                    XCA
                    TRA      1,4
     IALS           NULL
     IALSF          NULL
     ALSF           NULL
     ALS            CLA*     3,4
                    STA      *+2
                    CAL*     4,4
                    ALS      **
                    XCL
                    XCA
                    TRA      1,4
     XLRS           NULL
     XLRSF          NULL
     LRSF           NULL
     LRS            CLA*     3,4
                    STA      *+3
                    CAL*     4,4
                    LDQ      TEMP
                    LRS      **
```

```
                STQ     TEMP
                XCL
                XCA
                TRA     1,4
        XLLS    NULL
        LLSF    NULL
        XLLSF   NULL
        LLS     CLA*    3,4
                STA     *+3
                CAL*    4,4
                LDQ     TEMP
                LLS     **
                STQ     TEMP
                XCL
                XCA
                TRA     1,4
        EXORF   NULL
        IEXOR   NULL
        EXOR    CAL*    3,4
                ERA*    4,4
                XCL
                XCA
                TRA     1,4
        ALGL    NULL
        LGLF    NULL
        ALGLF   NULL
        LGL     CLA*    3,4


                STA     *+3
                CAL*    4,4
                LDQ     TEMP
                LGL     **
                STQ     TEMP
                XCL
                XCA
                TRA     1,4
        ALGR    NULL
        ALGRF   NULL
        LGRF    NULL
        LGR     CLA*    3,4
                STA     *+3
                CAL*    4,4
                LDQ     TEMP
                LGR     **
                STQ     TEMP
                XCL
                XCA
                TRA     1,4
        TEMP    OCT
                END
```

APPENDIX C

EXAMPLE OF COMPUTER OUTPUT - GROUP A$_5$

```
   K2*K2
(1,2,3,4,5)
(1,2,3,4,5).(1,2,5,3,4).(1,4,5,2,3).(1,4,2,3,5).(1,3,5,4,2).(1,3,4,2,5).
(5,4,3,2,1).(5,2,1,4,3).(5,4,1,3,2).(5,3,2,4,1).(5,3,1,2,4).(5,2,4,3,1).

(1,2,3,4,5).(1,2,5,3,4).(1,4,5,2,3).(1,4,2,3,5).(1,3,5,4,2).(1,3,4,2,5).
(5,4,3,2,1).(5,2,1,4,3).(5,4,1,3,2).(5,3,2,4,1).(5,3,1,2,4).(5,2,4,3,1).

      GROUP (1,2,3,4,5)
                                      K2*K2
```

	(1,2,3,4,5).	(1,2,5,3,4).	(1,4,5,2,3).	(1,4,2,3,5).	(1,3,5,4,2).	(1,3,4,2,5).
(1,2,3,4,5).	(3,5,2,4,1)	(3,5,4,2,1)	(5,3,2,4,1)	(5,2,4,3,1)	(4,3,1)	(4,3,5,2,1)
(1,2,5,3,4).	(5,2,4,3,1)	(5,4,2,3,1)	(4,3,2)	(4,5,2)	(4,5,1)	(4,5,2,3,1)
(1,4,5,2,3).	(3,5,4,2,1)	(3,5,1)	(5,3,4,2,1)	(5,4,3,2,1)	(4,3,2)	(5,4,3)
(1,4,2,3,5).	(3,2,5,4,1)	(3,2,1)	(2,5,3,4,1)	(2,5,4,3,1)	(5,2,4,3,1)	(5,4,3,2,1)
(1,3,5,4,2).	(5,3,2)	(4,3,2)	(2,5,1)	(2,5,3,4,1)	(5,2,3,4,1)	(5,3,2,4,1)
(1,3,4,2,5).	(5,3,2,4,1)	(5,4,3,2,1)	(2,4,1)	(2,4,5,3,1)	(4,5,2,3,1)	(4,5,3,2,1)
(5,4,3,2,1).	E	(4,5,2)	(3,5,1)	(3,4,1)	(2,5,3,4,1)	(2,4,1)
(5,2,1,4,3).	(5,4,2)	E	(3,4,2,5,1)	(3,2,5,4,1)	(5,3,2,4,1)	(5,4,1)
(5,4,1,3,2).	(5,3,1)	(5,2,4,3,1)	E	(4,5,3)	(2,3,4,5,1)	(2,4,5,3,1)
(5,3,2,4,1).	(4,3,1)	(4,5,2,3,1)	(5,4,3)	E	(2,5,1)	(2,3,1)
(5,3,1,2,4).	(4,3,5,2,1)	(4,2,3,5,1)	(5,4,3,2,1)	(5,2,1)	E	(3,5,2)
(5,2,4,3,1).	(4,2,1)	(4,5,1)	(3,5,4,2,1)	(3,2,1)	(5,3,2)	E

	(5,4,3,2,1).	(5,2,1,4,3).	(5,4,1,3,2).	(5,3,2,4,1).	(5,3,1,2,4).	(5,2,4,3,1).
(1,2,3,4,5).	E	(5,3,1)	(4,2,1)	(5,4,2)	(3,2,5,4,1)	(5,3,2)
(1,2,5,3,4).	(3,5,1)	E	(4,2,3,5,1)	(3,5,4,2,1)	(5,4,3,2,1)	(3,2,1)
(1,4,5,2,3).	(2,4,1)	(5,3,2,4,1)	E	(2,5,1)	(3,4,2,5,1)	(2,5,3,4,1)
(1,4,2,3,5).	(4,5,2)	(2,4,5,3,1)	(5,2,1)	E	(3,4,1)	(4,5,3)
(1,3,5,4,2).	(4,5,2,3,1)	(2,3,4,5,1)	(5,2,4,3,1)	(4,3,1)	E	(4,5,1)
(1,3,4,2,5).	(3,5,2)	(2,3,1)	(4,3,5,2,1)	(5,4,3)	(5,4,1)	E
(5,4,3,2,1).	(4,2,5,3,1)	(3,4,2,5,1)	(2,4,5,3,1)	(4,5,2,3,1)	(3,5,2)	(4,2,3,5,1)
(5,2,1,4,3).	(2,4,5,3,1)	(3,2,4,5,1)	(5,3,1)	(2,3,1)	(3,4,2)	(2,3,4,5,1)
(5,4,1,3,2).	(4,2,3,5,1)	(3,4,2)	(2,4,3,5,1)	(4,3,5,2,1)	(5,2,1)	(4,2,1)
(5,3,2,4,1).	(3,4,2,5,1)	(5,4,2)	(2,4,3,5,1)	(3,4,5,2,1)	(4,3,5,2,1)	(3,5,4,2,1)
(5,3,1,2,4).	(3,4,1)	(5,4,1)	(3,4,2)	(3,4,2,5,1)	(4,2,5,1)	(3,2,5,4,1)
(5,2,4,3,1).	(2,5,3,4,1)	(3,2,5,4,1)	(4,5,3)	(2,3,4,5,1)	(4,2,3,5,1)	(2,3,5,4,1)

```
   K3*K3
(1,2,3,4,5)
(1,3,5,2,4).(1,5,4,2,3).(1,5,3,4,2).(1,2,5,4,3).(1,5,2,3,4).(1,4,5,3,2).
(5,3,1,4,2).(5,1,3,2,4).(5,1,2,4,3).(5,2,1,3,4).(5,1,4,3,2).(5,4,1,2,3).

(1,3,5,2,4).(1,5,4,2,3).(1,5,3,4,2).(1,2,5,4,3).(1,5,2,3,4).(1,4,5,3,2).
(5,3,1,4,2).(5,1,3,2,4).(5,1,2,4,3).(5,2,1,3,4).(5,1,4,3,2).(5,4,1,2,3).

      GROUP (1,2,3,4,5)
                                      K3*K3
```

	(1,3,5,2,4).	(1,5,4,2,3).	(1,5,3,4,2).	(1,2,5,4,3).	(1,5,2,3,4).	(1,4,5,3,2).
(1,3,5,2,4).	(5,4,3,2,1)	(2,5,1)	(2,3,1)	(3,5,2,4,1)	(2,5,4,3,1)	(3,4,2)
(1,5,4,2,3).	(4,5,3)	(4,3,5,2,1)	(4,3,2,5,1)	(3,5,2,4,1)	(4,5,3,2,1)	(2,5,1)
(1,5,3,4,2).	(4,5,1)	(3,5,2,4,1)	(3,2,5,4,1)	(3,5,2)	(3,2,4,5,1)	(2,5,4,3,1)
(1,2,5,4,3).	(3,4,2)	(4,5,3,2,1)	(4,5,3,2,1)	(4,5,1)	(5,3,2,4,1)	(3,5,1)
(1,5,2,3,4).	(4,5,3,2,1)	(2,4,5,3,1)	(2,4,5,3,1)	(3,5,1)	(3,5,1)	(5,4,2)
(1,4,5,3,2).	(2,5,1)	(3,4,1)	(3,5,2,4,1)	(3,4,2)	(3,4,2)	(5,2,4,3,1)
(5,3,1,4,2).	E	(3,4,5,2,1)	(3,2,4,5,1)	(4,2,1)	(5,7,3,4,1)	(2,4,3,5,1)
(5,1,3,2,4).	(2,5,4,3,1)	E	(3,5,2)	(4,2,1)	(5,4,3)	(5,2,3,4,1)
(5,1,2,4,3).	(5,4,2,3,1)	(5,3,2)	(2,4,1)	(4,5,3,2,1)	(5,4,2)	(3,4,1)
(5,2,1,3,4).	(4,3,2,5,1)	(2,4,1)	(2,3,5,4,1)	E	(2,4,3,5,1)	(5,4,2,3,1)
(5,1,4,3,2).	(2,3,1)	(5,4,2,3,1)	(4,5,3)	(4,5,2)	(5,3,4,2,1)	(3,5,2,4,1)
(5,4,1,2,3).	(5,3,4,2,1)	(4,3,2,5,1)	(4,3,1)	(4,3,1)	(3,2,4,5,1)	E

	(5,3,1,4,2).	(5,1,3,2,4).	(5,1,2,4,3).	(5,2,1,3,4).	(5,1,4,3,2).	(5,4,1,2,3).
(1,3,5,2,4).	E	(5,3,4,2,1)	(4,5,3,2,1)	(5,4,2,3,1)	(4,5,3)	(4,3,2,5,1)
(1,5,4,2,3).	(2,4,3,5,1)	E	(3,4,1)	(5,3,2)	(2,4,1)	(3,4,5,2,1)
(1,5,3,4,2).	(2,3,5,4,1)	(4,3,1)	(5,2,3,4,1)	(4,3,2,5,1)	(2,3,1)	(4,5,2)
(1,2,5,4,3).	(3,2,4,5,1)	(3,5,2)	(3,2,1)	E	(3,5,2,4,1)	(5,3,4,2,1)
(1,5,2,3,4).	(5,4,3)	(4,2,1)	(5,4,2)	(4,2,5,3,1)	E	(3,2,4,5,1)
(1,4,5,3,2).	(5,2,3,4,1)	(2,5,4,3,1)	(5,4,1)	(2,4,3,5,1)	(5,4,2,3,1)	E
(5,3,1,4,2).	(5,2,1)	(2,5,3,4,1)	(4,2,5,3,1)	(5,4,1)	(2,3,5,4,1)	(5,2,1)
(5,1,3,2,4).	(3,2,1)	(5,2,3,4,1)	(4,5,2,3,1)	(4,2,3,5,1)	(4,4,3,1)	(4,3,1)
(5,1,2,4,3).	(5,4,1)	(4,2,5,3,1)	(5,3,2)	(2,3,5,4,1)	(5,3,4,2,1)	(4,2,5,3,1)
(5,2,1,3,4).	(3,2,1)	(5,2,3,4,1)	(4,2,5,3,1)	(5,4,1)	(3,4,5,2,1)	(4,3,2)
(5,1,4,3,2).	(5,4,1)	(4,2,5,3,1)	(5,3,2)	(4,2,3,5,1)	(5,3,1)	(5,3,1)
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K4*K4
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(1,2,3).-(2,3,4).-(1,3,4).-(1,2,4).-(1,2,5).-(1,3,5).-(2,3,5).-(1,4,5).-(2,4,5).-(3,4,5).-
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GROUP (1,2,3,4,5)

K4*K4

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K5*K5

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(1,2)(3,4).-(1,3)(2,4).-(1,4)(2,3).-(1,2)(3,5).-(1,3)(2,5).-(1,5)(2,3).-(1,2)(4,5).-
(1,4)(2,5).-(1,5)(2,5).-(1,3)(4,5).-(1,4)(3,5).-(2,3)(4,5).-(2,4)(3,5).-(2,4)(3,5).
(2,5)(3,4).

GROUP (1,2,3,4,5)

K5*K5

(1,2)(3,4).-	(1,2)(4,5).-	(1,3)(2,4).	(1,2)(3,4).	(1,4)(2,3).	(1,2)(3,5).
(1,3)(2,4).-	(4,5,3)	(4,1)(3,2)	(4,1)(4,3)	(3,1)(4,2)	(5,2,4)
(1,4)(2,3).-	(4,5,2,3,1)	E	E	(2,1)(4,3)	(4,2,3,5,1)
(1,2)(3,5).-	(4,5,3)	(4,1)(3,2)	(5,3,2,4,1)	(4,2,5,3,1)	(3,5,2,4,1)
(1,3)(2,5).-	(5,2,3,4,1)	(3,1)(4,2)	(4,5,2)	(4,3,5,2,1)	(5,1)(3,2)
(1,2)(4,5).-	(3,4,2,5,1)	(4,5,3)	(5,2,3,4,1)	(4,5,1)	(3,1)(5,2)
(1,4)(2,5).-	(5,2,4,3)	(4,5,2)	(3,4,2,5,1)	(5,4,2,3,1)	E
(1,5)(2,4).-	(4,3,2,5,1)	(5,2,4,3,1)	(3,5,1)	(3,5,2)	(4,5,2,3,1)
(1,3)(4,5).-	(2,3,5,4,1)	(3,2,4,5,1)	(5,4,2)	(2,3,4,5,1)	(3,2,4,5,1)
(1,4)(3,5).-	(2,5,1)	(2,5,4,3,1)	(5,3,4,2,1)	(2,4,1)	(3,4,1)
(1,5)(3,4).-	(3,5,4,2,1)	(4,5,3,2,1)	(4,5,4,2,1)	(3,4,5,2,1)	(4,5,2)
(2,3)(4,5).-	(5,2,1)	(2,5,4,3,1)	(2,5,4,3,1)	(5,4,2,3,1)	(5,2,3,4,1)
(2,4)(3,5).-		(4,3,2,5,1)	(3,4,1)	(4,2,1)	(2,4,1)
(2,5)(3,4).-				(3,5,3,4,1)	(3,4,5,3,1)
				(5,2)(4,3)	(4,3,1)

K2*K3

(1,2,3,4,5)
(1,3,5,2,4).-(1,5,4,2,3).-(1,2,5,4,3).-(1,2,5,3,4).-(1,4,5,3,2).
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(1,2,3,4,5).-(1,2,5,3,4).-(1,4,5,2,3).-(1,3,5,2,3).-(1,3,4,2,5).
(5,4,3,2,1).-(5,2,1,4,3).-(5,4,1,3,2).-(5,3,2,4,1).-(5,2,4,3,1).

GROUP (1,2,3,4,5)

K2*K3

(1,2,3,4,5).   (1,3,5,2,4).   (1,5,4,2,3).   (1,5,4,2,3).   (1,5,3,4,2).   (1,5,2,3,4).   (1,4,5,3,2).
(1,2,5,3,4).   (4,2,5,3,1)   (4,3,2)   (5,4,3)   (3,2,1)   (4,2)(5,3)   (5,4,1)
(1,4,5,2,3).   (4,2,1)   (3,2,4,5,1)   (3,1)(5,4)   (5,1)(3,2)   (3,1)(4,2)   (5,4,3)
(1,4,5,2,5).   (5,3,2)   (2,1)(4,3)   (2,4,3,5,1)   (3,4,1)   (2,4,3,5,1)   (5,1)(4,2)
(1,3,5,4,2).   (5,3,1)   (5,2)(4,3)   (4,3,2)   (4,5,2,1)   (5,3,2)   (2,3,1)
(1,3,4,2,5).   (5,1)(4,3)   (4,1)(5,2)   (4,1)(3,2)   (4,5,2)   (4,3,2)   (2,3,5,4,1)
(5,4,2,3,1).   (4,3,1)   (4,5,2)   (3,2)(5,4)   (5,2,1)   (4,5,1)   (3,1)(5,2)
(5,4,1,4,3).   (2,3,4,5,1)   (4,1)(5,3,2)   (4,2,1)   (4,2)(5,3)   (2,5,1)   (3,5,1)(4,2)
(5,2,1,4,3).   (5,1)(3,2)   (2,5,3,4,1)   (2,4,1)   (4,5,3)   (4,3,1)   (3,5,2)(4,1)
(5,3,2,4,1).   (2,1)(5,4)   (4,5,1)   (5,1)(4,2)   (5,1)(4,2)   (3,1)(5,2)   (5,2)(4,3)
(5,3,1,2,4).   (2,1)(5,4,3)   (3,5,1)   (4,2,3,5,1)   (4,2,3,5,1)   (3,5,4,2,1)   (5,1)(4,3)
(5,2,4,3,1).   (5,4,2)   (3,2,1)   (3,5,1)   (4,1)(3,2)   (2,1)(5,4)   (3,4,2,5,1)
(5,2,4,3,1).   (3,2)(5,4)   (2,1)(5,4)   (3,5,1)   (4,1)(5,3)   (3,4,2,5,1)

(1,2,3,4,5).   (5,3,1,4,2).   (5,1,3,2,4).   (5,1,2,4,3).   (5,2,1,3,4).   (5,1,4,3,2).   (5,4,1,2,3).
(1,2,5,3,4).   (3,4,3,2,1)   (4,1)(5,2)   (3,1)(5,2)   (4,1)(5,2)   (5,2,1)   (3,1)(4,2)
(1,4,5,2,3).   (5,1)(3,2)   (4,3,5,2,1)   (5,2,1)   (4,3,1)   (5,4,1)   (5,1)(4,2)
(1,4,2,3,5).   (2,1)(4,3)   (5,4,2)   (3,2,5,4,1)   (5,3,2)   (4,3,1)   (3,2,1)
(1,3,5,4,2).   (2,4,1)   (5,4,1)   (5,4,2)   (5,3,2,4,1)   (5,1)(3,2)   (3,1)(5,2)
(1,3,4,2,5).   (2,1)(5,4)   (5,3,1)   (5,3,1)   (4,5,3)   (2,4,5,3,1)   (5,2,1)
(5,4,3,2,1).   (3,6,2,4,1)   (3,4,2)   (3,4,2)   (3,4,2)   (2,1)(5,3)   (5,2,4,3,1)
(5,4,1,3,2).   (3,4,1)   (5,1)(4,2)   (5,1)(4,2)   (3,2)(5,4)   (2,5,1)   (4,5,3)
(5,4,1,3,2).   (3,2)(5,4)   (5,3,4,2,1)   (3,1)(4,2)   (3,1)(4,2)   (5,1)(4,2)   (5,1)(4,3)
(5,3,2,4,1).   (4,5,2)   (4,2,1)   (2,5,4,3,1)   (4,2)(5,3)   (4,2)(5,3)   (4,5,2)
(5,3,1,2,4).   (3,5,1)   (4,2,3,5,1)   (2,3,4,5,1)   (2,5,4,3,1)   (3,4,2,5,1)   (4,2,1)
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(3,5,1).   (3,4,2)   (4,1)(3,2)   (5,4,2)   (5,4,2)   (4,5,3,2,1)

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K2*K4
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GROUP (1,2,3,4,5)

K2*K4

24

K2*K5

(1,2,3,4,5)
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(2,5)(3,4).

(1,2,3,4,5).(1,2,5,3,4).(1,4,5,2,3).(1,4,2,3,5).(1,3,5,4,2).(1,3,4,2,5).
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GROUP (1,2,3,4,5)

K2*K5

(1,2)(3,4).   (1,3)(2,4).   (1,4)(2,3).   (1,5)(2,3).   (1,5)(3,4).

(1,5)(2,3).   (2,5)(3,4).

K3*K2

(1,2,3,4,5)
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GROUP (1,2,3,4,5)

(1,2,3,4,5).	(1,2,5,3,4).	(1,4,5,2,3).	(1,4,2,3,5).	(1,3,4,2,5).
(4,2,5,3,1)	(4,3,1)	(5,4,2)	(5,3,2)	(5,3,1)
(3,4,2)	(3,2,4,5,1)	(2,4,3,5,1)	(2,1,5,3)	(4,3,2)
(4,3,2)	(5,1,4,2)	(2,4,1)	(2,4,1)	(4,1)(3,2)
(5,2,1)	(5,1)(4,2)	(3,2,1)	(4,5,3)	(4,5,2)
(3,1)(4,2)	(3,1)(5,4)	(4,2)(5,3)	(4,2)(5,3)	(4,3,1)
(5,4,3,2)	(3,7,5,2)	(5,1)(4,3)	(5,4,1)	(2,3,5,4,1)
(5,4,3,2,1)	(5,4,3,2,1)	(2,1)(4,3)	(2,1)(5,4)	(3,2)(5,4)
(4,1)(5,3)	(2,1)(3,2)	(5,4,1)	(2,3,1)	(2,1)(5,3)
(4,1)(5,2)	(4,3,5,2,1)	(3,2,5,4,1)	(5,3,1)	(5,2,1)
(5,4,1)	(5,4,2)	(5,3,2,4,1)	(5,3,2,4,1)	(4,1)(5,3)
(5,2,1)(5,3)	(5,4,3)	(3,4,1)	(3,4,1)	(2,1)(5,4)
(5,4,1,2,3)	(3,1)(4,2)	(5,2)(4,3)	(5,2)(4,3)	(5,2,4,3,1)

K3*K2

(5,4,3,2,1).	(1,2,5,4,3).	(5,4,1,3,2).	(5,4,1,2,3).	(5,2,4,3,1).
(2,3,4,5,1)	(3,2)(5,3)	(5,1)(4,3)	(2,1)(4,3)	(2,1)(5,4)
(4,1)(5,2)	(2,5,3,4,1)	(4,5,2)	(3,5,1)	(4,1)(5,3)
(3,1)(5,3)	(2,5,1)	(4,5,2,3,1)	(5,4,3)	(3,5,1)
(4,1)(5,3)	(3,4,2)	(4,2)(5,3)	(4,2,3,5,1)	(4,1)(5,3)
(3,1)(4,2)	(5,1)(4,2)	(4,5,1)	(2,1)(5,4)	(3,4,2,5,1)
(3,5,2,4,1)	(2,4,1)	(2,3,1)	(3,1)(5,2)	(3,4,1)
(3,5,1)	(2,4,2,3,1)	(3,5,2)	(3,5,1)	(5,4,2)
(3,4,2)	(5,4,2,3,1)	(5,2)(4,3)	(4,1)(4,3)	(3,2)(5,4)
(2,3,1)	(3,1)(5,4)	(5,3,4,2,1)	(4,1)(3,2)	(2,5)(5,4)
(5,2,1)(5,3)	(5,1)(3,2)	(4,3,1)	(5,4,2)	(3,4,2)
(4,5,1)	(3,1)(4,2)	(2,1)(5,3)	(5,2,3,4,1)	(4,5,3,2,1)

(1,2,3,4,5)
(1,2,3).(2,3,4).(1,3,4).(1,2,4).(1,2,5).(1,3,5).(2,3,5).(1,4,5).(2,4,5).(3,4,5).
(3,2,1).(4,3,2).(4,3,1).(5,2,1).(5,3,1).(5,3,2).(5,4,1).(5,4,2).(5,4,3).

(1,3,5,2,4).(1,5,4,2,3).(1,2,5,3,4).(1,2,4,5,3).(1,5,2,3,4).(1,4,5,3,2).
(5,3,1,4,2).(5,1,3,2,4).(5,1,2,3,4).(5,2,1,3,4).(5,1,4,3,2).(5,4,1,2,3).

GROUP (1,2,3,4,5)

K3*K4

(1,2,3).	(2,3,4).	(1,2,4).	(1,2,5).	(1,3,5).
(4,1)(5,2)	(3,1)(5,2)	(4,3,5,2,1)	(3,1)(4,2)	(5,3,2,4,1)
(3,5,4,2,1)	(5,4,2,4,1)	(3,1)(5,4)	(4,5,3)	(3,1)(4,2)
(4,2)(5,3)	(4,2)(5,3)	(4,5,3,2,1)	(3,4,2)	(4,2,1)
(5,4,3,2,1)	(2,1)(5,4)	(5,2)(4,3)	(5,2)(4,3,1)	(5,2)(4,3)
(3,5,2,4,1)	(5,2,4,3,1)	(3,4,5,2,1)	(3,4,5,1)	(4,1)(3,2)
(4,1)(5,3)	(4,1)(5,3)	(5,3,2)	(3,2)(5,4)	(5,4,2)
(4,5,3)	(3,5,1)	(5,3,1)	(5,3,1)	(5,4,2)
(5,3,1)	(2,5,1)	(4,3,2,5,1)	(4,5,2,3,1)	(2,4,5,3,1)
(4,3,2,5,1)	(5,1)(4,2)	(5,1)(4,2)	(4,3,5,1)	(5,4,3,1)
(4,5,2,1)	(3,5,2,4,1)	(5,2)(4,3)	(5,2)(4,3)	(4,5,3,2,1)
(5,1)(4,3)	(4,5,1)	(5,1)(3,2)	(5,4,3,2,1)	(2,5,4,3,2)
(3,2,5,4,1)	(2,5,3,4,1)	(3,5,4,2,1)	(3,5,4,2,1)	(5,2,3,4,1)

(2,3,5).	(1,4,5).	(2,4,5).	(1,2,4).	(1,3,5).
(3,2,5,4,1)	(4,2)(5,3)	(3,5,4,2,1)	(5,2,3,4,1)	(5,4,5,2,1)
(5,3,4,2,1)	(2,3,1)	(5,3,1)	(5,2,3,4,1)	(5,4,1)
(5,1)(4,2)	(3,1)(4,2)	(5,3,1)	(4,2,5,3,1)	(5,3,1)
(2,1)(5,3)	(3,4,2)	(2,3,1)	(4,3,2,5,1)	(2,3,5,4,1)
(5,3,2,4,1)	(5,4,2,4,1)	(4,3,2,5,1)	(2,4,5,3,1)	(4,2,5,3,1)
(2,5,4,3,1)	(4,2,3,5,1)	(4,3,2,5,1)	(4,3,2,5,1)	(2,3,4,5,1)
(4,2,1)	(4,3,1)	(4,3,1)	(5,1)(4,3)	(4,1)(5,3)
(3,5,1)	(2,3,5,4,1)	(2,3,5,4,1)	(5,1)(4,3)	(2,3,4,5,1)
(2,5,1)	(2,5,3,4,1)	(3,5,2,4,1)	(4,5,2,3,1)	(3,1)(5,2)
(3,5,2,4,1)	(3,2,5,4,1)	(4,1)(5,2)	(5,2)(4,3)	(4,2,3,5,1)
(4,5,1)	(3,2,5,4,1)	(4,1)(5,2)	(5,1)(3,2)	(5,4,3,2)
(2,5,3,4,1)	(3,5,2)	(2,3,1)	(4,1)(3,2)	(4,2,3,5,1)

(4,3,1).	(5,2,1).	(5,3,1).	(5,4,1).	(5,4,1).
(4,5,2)	(2,4,1)	(2,4,1)	(3,4,1)	(4,3,5,1)
(2,5,4,3,1)	(2,3,5,4,1)	(4,2,3,5,1)	(5,1)(4,2)	(4,5,2,3,1)
(5,2,4,3,1)	(5,2,1)	(4,3,2,5,1)	(5,4,2,5,1)	(3,4,2,5,1)
(2,4,5,3,1)	(2,5,3,4,1)	(2,3,5,4,1)	(5,4,1)	(2,5,3,4,1)
(5,1)(4,3)	(5,1)(4,3)	(5,2)(4,3)	(4,5,2,3,1)	(3,1)(5,2)
(2,5,3,4,1)	(2,5,3,4,1)	(3,1)(4,2)	(3,4,2,5,1)	(4,2,1)
(5,1)(4,2)	(5,1)(4,2)	(4,5,2)	(4,5,2)	(4,1)(5,2)
(5,2,1)	(3,2)(5,4)	(4,3,2)	(3,2)(5,4)	(2,1)(5,3)
(3,4,2,5,1)	(2,3,5,4,1)	(2,4,3,5,1)	(2,1)(5,4)	(5,4,3,2)
(3,2)(5,4)	(4,3,2)	(5,2)(4,3)	(5,2)(4,3)	(4,3,5,1)
(3,2)(4,5)	(4,1)(5,3)	(4,3,2)	(4,3,1)	(2,4,3,5,1)

(5,4,2).	(5,4,3).
(3,5,1)	(3,4,5,2,1)
(5,2,4,3,1)	(5,2,4,3,1)
(5,2,1)	(5,4,1)
(2,4,5,3,1)	(2,3,5,4,1)
(5,1)(4,3)	(5,2,4,1)
(4,2,1)	(4,2,1)
(4,1)(5,2)	(5,4,2,3,1)
(2,1)(5,2)	(3,1)(4,2)
(2,4,1)(5,3)	(2,4,5,3,1)
(3,4,1)	(5,4,3,2)
(4,3,2,5,1)	(4,2,3,5,1)
(2,4,3,5,1)	(2,4,3,5,1)

27

K3*K5

(1,2,3,4,5)
(1,2)(3,4)-(1,3)(2,4)-(1,4)(2,3)-(1,2)(3,5)-(1,3)(2,5)-(1,5)(2,3)-(1,2)(4,5)-
(1,4)(2,5)-(1,5)(2,4)-(1,3)(4,5)-(1,5)(3,4)-(1,4)(3,5)-(2,3)(4,5)-(2,4)(3,5)-
(2,5)(3,4).

(1,3,5,2,4)-(1,5,4,2,3)-(1,5,2,4,3)-(1,2,3,5,4)-(1,4,5,3,2)-(1,4,5,3,2)-
(5,3,1,4,2)-(5,1,3,2,4)-(5,1,2,4,3)-(5,2,1,3,4)-(5,1,4,3,2)-(5,4,1,2,3).

GROUP (1,2,3,4,5)

K3*K5

(1,2)(3,4).   (1,3)(2,4).   (1,4)(2,3).
(4,5,2,3,1)   (5,2,1)   (5,2,1)(4,3)
(1,5,3,4,2)   (5,4,3)   (3,4,2,5,1)
(3,2)   (4,1)(5,3)   (2,4,5,3,1)
(5,4,1)   (3,2)(5,4)   (4,1)(5,2)
(3,1)(5,2)   (4,1)(4,2)   (5,3,1)
(4,2)(5,3)   (2,5,1)   (2,1)(5,3)
(4,5,3,1)   (4,5,3)   (5,1)(4,3)
(4,1)(3,2)   (5,1)(3,2)   (3,4,2,5,1)
(3,4,2)   (4,1)(5,2)   (5,2,4,3,1)
(3,5,2)   (3,4,2)   (3,5,1)
(5,1)(4,2)   (5,3,2,4,1)   (5,2,4,3,1)
(3,1)(5,2)   (3,1)(5,2)   (3,4,1)

(1,3,5,2,4). (1,4)(2,5).   (1,5)(2,4).
(4,2,5,3,1)   (5,4,3,1)   (4,3,1)
(3,1)(5,2)   (2,4,5,3,1)   (3,2,1)
(5,2,4,3,1)   (3,1)(5,2)   (4,3,1)
(5,3,2,1)   (5,2,1)   (3,1)(4,2)
(3,4,2,5,1)   (4,5,3,1)   (4,5,2,3,1)
(5,1)(3,2)   (2,1)(4,3)   (2,1)(4,3)
(4,1)(3,2)   (5,1)(3,2)   (3,1)(5,2)
(4,1)(3,2)   (2,3,1)   (5,3,2)
(3,4,2)   (5,4,3,1)   (3,5,4,1)
(3,5,2)   (3,2,1)   (4,2)(5,3)
(5,1)(4,2)   (4,2)(5,3)   (2,5,3,4,1)
(3,1)(5,2)   (4,2)(5,3)   (4,3)

(2,3)(4,5).   (2,5)(3,4).   (2,4)(3,5).
(3,4,2,5,1)   (3,1)(5,4)   (2,4,5,1)
(3,2,1)   (5,4,2,1)   (3,1)(5,4)
(5,2,4,3,1)   (5,1)(4,3)   (5,1)(4,3)
(2,1)(5,3)   (2,3,4,5,1)   (2,3,4,5,1)
(5,4,3,1)   (5,4,3,1)   (4,1)
(4,3,1)   (4,3,2)   (5,3,1)
(4,5,3,2)   (4,1)(3,2)   (3,5,4,2,1)
(3,4,1)   (3,1)(5,2)   (3,2,5,1)
(2,5,3,4,1)   (2,3,1)   (2,1)(5,4)
(3,1)(4,2)   (5,1)   (4,2,1)
(4,2,1)   (4,2,1)   (4,5,2,3,1)
(2,5,1)   (2,3,1)   (2,4,5,3,1)

(1,5)(2,3).   (1,3)(2,5).   (1,5)(2,3).
(2,5,3,4,1)   (5,4,1)   (2,5,3,4,1)
(3,4,2,5,1)   (4,2)(5,3)   (2,5,3,4,1)
(4,2)(5,1)   (3,4,2,5,1)   (4,1)(3,2)
(4,3,5,2,1)   (3,2)(5,4)   (4,1)(5,2)
(2,4,1)   (2,5,4,1)   (2,3,1)
(3,1)(5,4)   (5,2,1)   (3,5,4,5,1)
(3,5,4,5,1)   (5,2,1)   (3,2,5,4,1)
(4,5,2,1)   (2,5,4,1)   (4,5,2,1)
(5,4,3,2,1)   (4,3,2,1)   (2,1)(5,3)
(2,4,1)   (5,1)(3,2)   (5,4,2)
(5,4,3,2,1)   (5,4,2)   (2,5,1)(5,3)
(3,4,2)   (3,4,2)   (4,5,2,3,1)

K4*K2

(1,2,3,4,5)
(1,2,3,4,5).(1,2,5,3,4).(1,4,5,2,3).(1,4,5,2,3).(1,3,5,4,2).
(5,4,3,2,1).(5,4,1,3,2).(5,3,2,4,1).(1,2,5).(2,4,5).(3,4,5).
(3,2,1).(4,3,2).(4,2,1).(5,2,1).(5,3,2,4).(5,4,2).(5,4,3,1).

GROUP (1,2,3,4,5)

K4*K2

K4*K3

(1,2,3,4,5)

(1,3,5,2,4)·(2,3,4)·(1,5,4,2,3)·(1,2,5,4,3)·(1,5,2,3,4)·(1,4,5,3,2)·
(5,3,1,4,2)·(5,1,3,2,4)·(4,3,1)·(4,3,2)·(5,2,1,3,4)·(1,4,5)·(2,4,5)·(3,4,5)·
(3,2,1)·(4,3,2)·(4,3,1)·(5,2,1)·(5,3,1)·(5,3,2)·(5,4,2)·(5,4,1)·(5,4,3)·

GROUP (1,2,3,4,5)   K4*K3

(1,2,3)·   (1,3,5,2,4)·   (1,5,4,2,3)·   (1,2,5,4,3)·   (1,5,2,3,4)·   (1,4,5,3,2)·
(2,3,4)·   (4,2)(5,3)   (5,3,4,2,1)   (3,1)(5,2)   (5,3,4,2,1)   (4,5,1)
(3,4,5)·   (4,1)(5,3)   (5,2,4,3,1)   (2,5,1)   (5,3,2,4,1)   (2,1)(5,4)
(1,3,4)·   (3,5,4,2,1)   (5,4,2)   (4,3,2,5,1)   (5,2,4,3,1)   (3,2)(5,4)
(1,2,4)·   (3,1)(4,2)   (5,1)(4,2)   (5,4,3,2,1)   (3,4,2)   (4,1)(5,3)
(1,2,5)·   (5,2,4,3,1)   (3,2)(5,4)   (2,1)(5,4)   (5,2)(4,3)   (4,1)(5,3)
(1,3,5)·   (5,1)(3,2)   (2,1)(4,3)   (3,2)(5,4)   (2,5,3,4,1)   (4,2,1)
(2,3,5)·   (3,4,1)   (2,3,1)   (2,1)(5,3)   (2,3,5,4,1)   (5,2,1)
(1,4,5)·   (2,3,5,4,1)   (3,1)(4,2)   (4,3,1)   (3,5,7,4,1)   (5,3,4,2,1)
(2,4,5)·   (3,5,1)   (5,4,3,1)   (2,3,1)   (5,1)(4,3)   (5,4,2,1)
(3,4,5)·   (4,1)(5,2)   (5,2,1)   (3,1)   (5,4,1)   (4,5,2,1)
(3,2,1)·   (2,3,5,4,1)   (5,2,3,4,1)   (5,4,2)   (5,2,1)   (3,4,5,2,1)
(4,3,2)·   (3,5,1)   (2,3,5,4,1)   (4,2,5,3,1)   (5,1)(3,2)   (2,4,5,3,1)
(4,2,1)·   (4,2,1)   (5,4,3)   (2,5,2)(4,3)   (2,3,4,5,1)   (4,2,5,3,1)
(5,2,1)·   (3,4,5,2,1)   (3,1)(5,4)   (5,4,3,2,1)   (3,4,5,2,1)   (4,3,5,2,1)
(5,3,1)·   (3,4,1)   (4,5,2,1)   (5,4,2,3,1)   (3,4,5,2,1)   (5,3,2,4,1)
(5,3,2)·   (5,2,3,4,1)   (4,5,2,3,1)   (2,4,5,3,1)   (4,1)(3,2)   (2,1)(5,3)
(5,4,2)·   (2,4,1)   (4,5,2,3,1)   (5,2,4,3,1)   (4,2,3,5,1)   (3,2)
(5,4,1)·   (2,4,5,2,1)   (4,5,3,2,1)   (5,2,4,3,1)   (4,3,2)   (2,1)(5,3)
(5,4,3)·   (5,2,3,4,1)   (4,2,5,3,1)   (2,4,5,3,1)   (2,4,3,5,1)   (3,2,1)

(1,2,3)·   (5,1,3,2,4)·   (5,1,2,4,3)·   (5,2,1,3,4)·   (5,1,4,2,3)·   (5,4,1,2,3)·
(2,3,4)·   (4,5,2)   (4,5,2)   (4,5,3)   (4,1)(5,2)   (3,5,4,2,1)
(3,4,5)·   (2,4,5,1)   (4,5,3,1)   (4,5,2,1)   (2,5,1)   (3,5,2,4,1)
(1,3,4)·   (5,4,2)   (3,5,2,4,1)   (3,1)(5,4)   (5,3,2)   (2,4,3,5,1)
(1,2,4)·   (5,2,3)   (3,5,2,4,1)   (5,2)(4,3)   (3,4,1)   (5,4,3,2,1)
(1,2,5)·   (4,2,1)   (5,2,4,3,1)   (2,1)(5,4)   (4,1)   (5,4,2,3,1)
(1,3,5)·   (4,3,1)   (2,3,4,5,1)   (3,5,4,2,1)   (4,5,3,1)   (3,2,5,4,1)
(2,3,5)·   (5,3,1)   (2,5,4,1)   (5,3,4,2,1)   (4,3,2,5,1)   (4,5,4,3,1)
(1,4,5)·   (5,4,2,3,1)   (3,5,2,4,1)   (4,3,2,5,1)   (2,3,4,5,1)   (2,4,3,5,1)
(2,4,5)·   (4,1)(5,2)   (3,1)(5,4)   (2,3,5,4,1)   (2,5,4,1)   (4,5,3,2,1)
(3,4,5)·   (3,1)(5,4)   (3,5,2,4,1)   (4,5,2,1)   (4,3,5,1)   (3,5,2,4,1)
(4,2,1)·   (3,5,4,1)   (3,1)(5,2)   (4,2,3,5,1)   (5,4,2)   (3,2)(5,4)
(4,3,1)·   (2,5,3,4,1)   (3,4,5,2,1)   (2,5,4,3,1)   (3,5,4,1)   (2,1)(5,4)
(5,2,1)·   (4,1)   (3,1)   (3,4,2)   (3,1)(4,2)   (5,4,1)
(5,3,1)·   (5,1)(4,2)   (5,1)(4,2)   (5,1)(4,3)   (5,2)   (2,5,3,4,1)
(5,3,2)·   (2,5,3,1)   (2,3,5,2,1)   (2,1)(4,3)   (3,2)(5,4)   (2,3,5,4,1)
(5,4,2)·   (4,2)(5,1)   (3,1)(5,2)   (5,1)(4,2)   (5,1)(4,3)   (3,2)(5,4)
(5,4,1)·   (2,6,4,5,1)   (2,3,5,1)   (2,4,3,5,1)   (4,3,2)   (2,5,3,4,1)
(5,4,3)·   (3,1)(4,2)   (5,2,1)   (2,6,4,5,1)   (2,4,3,5,1)   (2,4,3,5,1)
                (5,2,1)   (5,2,1)   (2,3,4,5,1)   (3,2,1)   (3,2,4,5,1)

K4*K5

(1,2,3,4,5)
(1,2)(3,4),(1,4)(2,3),(1,2)(3,5),(1,5)(2,3),(1,2)(4,5),
(1,2)(3,4),(1,3)(2,4),(1,4)(2,3),(1,5)(2,3),(1,2)(4,5),
(1,4)(2,5),(1,5)(2,4),(1,4)(3,5),(2,3)(4,5),(2,4)(3,5),
(2,5)(3,4).

(1,2,3),(2,3,4),(1,3,4),(1,2,4),(1,2,5),(1,3,5),(3,4,5),(2,4,5),(3,4,5).
(3,2,1),(4,3,2),(4,3,1),(4,2,1),(5,2,1),(5,3,1),(5,4,2),(5,4,1),(5,4,3).

GROUP (1,2,3,4,5)

(1,2,3).	(1,2)(3,4).	(1,3)(2,4).	(1,4)(2,3).	(1,5)(2,4).	(1,2)(3,5).	(1,3)(2,5).	(1,5)(2,3).
(2,3,4).	(3,4,1).	(4,3,2).	(2,4,1).	(4,2,5,3,1).	(3,5,1).	(5,3,2).	(5,2,1).
(1,3,4).	(2,3,1).	(4,2,1).	(2,4,1).	(4,2,4,3,1).	(3,2,5,4,1).	(2,3,5,4,1).	(4,2,5,3,1).
(1,2,4).	(1,3,4).	(4,3,2).	(4,5,2,1).	(5,2,4,1).	(4,1)(5,3).	(4,1)(5,2).	(5,2,3,4,1).
(1,2,5).	(5,1)(4,3).	(5,1)(4,2).	(4,3,5,2,1).	(4,3,5,1).	(5,3,1).	(3,2,1).	(3,5,2).
(1,3,5).	(2,3,4,5,1).	(5,2,4,1).	(4,1)(5,2).	(4,5,2,1).	(3,2,1).	(3,2,1).	(2,5,1).
(1,4,5).	(3,4,5,2,1).	(3,5,4,1).	(4,3,5,2,1).	(2,4,3,5,1).	(2,4,5,3,1).	(3,4,5,2,1).	(3,4,5,1).
(3,4,5).	(4,3,5,2,1).	(3,1)(5,2).	(5,1)(3,2).	(5,4,2).	(4,5,3,2,1).	(3,1)(5,4).	(2,3,4,5,1).
(4,3,2).	(2,1)(5,3).	(4,2,5,1).	(5,4,2).	(2,4,1).	(2,1)(5,4).	(4,5,2,3,1).	(3,2,4,5,1).
(4,3,1).	(2,4,2).	(2,3,1).	(2,5,1).	(4,2,5,1).	(3,4,2).	(5,3,1).	(5,3,1).
(4,2,1).	(2,4,1).	(2,3,1).	(3,5,2).	(4,5,2).	(3,5,2).	(2,5,4,3,1).	(5,4,3,2,1).
(5,2,1).	(3,4,1).	(3,4,1).	(3,5,2).	(5,4,2).	(3,5,2).	(2,4,3,5,1).	(5,4,2,3,1).
(5,3,1).	(3,5,2,4,1).	(3,5,2,4,1).	(4,2,3,5,1).	(4,2,3,5,1).	(2,5,1).	(3,5,2).	(2,3,1).
(5,4,2).	(2,5,3,4,1).	(4,5,3,1).	(5,1)(4,3).	(2,1)(4,3).	(2,5,1).	(2,3,1).	(3,5,1).
(5,4,1).	(5,3,4,2,1).	(5,3,4,2,1).	(5,3,2,4,1).	(5,3,2,4,1).	(2,3,1).	(2,5,3,4,1).	(4,1)(3,2).
(5,4,3).	(2,1)(5,4).	(2,5,2,4,1).	(3,1)(5,4).	(3,5,2,4,1).	(5,2,1).	(3,1)(4,2).	(4,2,3,5,1).
	(2,1)(5,3).	(3,1)(5,4).	(3,5,2,4,1).	(3,5,2,4,1).	(5,3,1).	(5,2,4,3,1).	(4,2,3,5,1).

K4*K5

(2,3)(4,5). (2,4)(3,5). (2,5)(3,4).
(2,4,3,5,1). (2,5,3,4,1).
(2,4,5,1). (5,3,2).
(3,5,2). (3,1)(5,2).
(4,1)(5,3). (2,1)(4,3).
(4,3,2). (3,4,5,2,1).
(5,4,2). (3,5,2).
(5,4,1). (4,3,1).

31

K5*K2

(1,2,3,4,5)
(1,2,3,4,5).-(1,2,5,3,4).-(1,4,5,2,3).-(1,3,5,4,2).-(1,3,4,2,5).-
(5,2,3,4,1).-(5,2,1,3,4).-(5,4,1,3,2).-(5,3,1,4,2).-(5,3,1,2,4).-

(1,2)(3,4).-(1,3)(2,4).-(1,4)(2,3).-(1,2,3,5).-(1,2)(4,5).-
(1,4)(2,5).-(1,5)(2,4).-(1,3)(4,5).-(2,4)(3,5).-(2,3)(4,5).-
(2,5)(3,4).-

GROUP (1,2,3,4,5)

K5*K2

K5*K3

(1,2,3,4,5)
(1,3,5,2,4).(1,5,4,2,3).(1,5,3,4,2).(1,2,5,4,3).(1,4,5,3,2).
(5,3,1,4,2).(5,1,3,2,4).(5,1,2,3,5).(1,3)(2,5).(1,2)(4,5).(1,4,5,3,2).
(2,5)(3,4).

(1,2)(3,4).(1,3)(2,4).(1,4)(2,3).(1,2)(3,5).(1,3)(2,5).(1,2)(4,5).
(1,4)(2,5).(1,5)(2,4).(1,3)(4,5).(1,4)(3,5).(1,5)(2,3).(2,4)(3,5).
(2,5)(3,4).

GROUP (1,2,3,4,5)

K5*K3

(1,2)(3,4).   (1,3,5,2,4).   (1,5,4,2,3).   (1,2,5,4,3).   (1,2,5,3,4).   (1,4,5,3,2).
(1,3)(2,4).   (4,2,3,5,1).   (5,3,2,1).   (5,3,2).   (5,3,2).   (3,1)(5,4).
(1,4)(2,3).   (5,4,3).   (5,2,1).   (4,1)(3,2).   (4,1)(5,2).   (2,3,4,5,1).
(1,2)(3,5).   (2,1)(4,3).   (5,1)(4,3).   (5,2,5,4,1).   (3,4,2,5,1).   (4,5,2).
(1,3)(2,5).   (5,1)(4,2).   (2,1)(5,4).   (3,2)(5,4).   (3,2)(5,4).   (4,3,1).
(2,4,5,3,1).   (4,3,2).   (5,4,3).   (3,5,4,2,1).   (3,5,4,2,1).   (4,2,3,5,1).
(3,7,4,2,5,1).   (4,1)(3,2).   (4,1)(5,3).   (4,2,3,5,1).   (4,1)(5,3).   (5,3,1).
(3,2,1).   (2,3,4,5,1).   (2,4,5,3,1).   (2,3,6,2).   (2,4,5,3,1).   (4,2)(5,3).
(3,1)(5,4).   (3,5,2).   (3,5,2).   (3,2)(5,4).   (3,2)(5,4,1).   (2,5,3,4,1).
(5,2,1).   (4,2,1).   (4,2,1).   (4,3,5,2,1).   (4,3,5,2,1).   (5,1)(3,4,2).
(4,5,2,3,1).   (5,2,1).   (3,4,2,5,1).   (2,4,1).   (2,4,1).   (4,3,2).
(2,5,3,4,1).   (4,5,2,3,1).   (4,2)(5,3).   (2,1)(5,3).   (2,1)(5,3).   (2,1)(4,3).
(5,4,1).   (3,1)(5,4).   (3,1)(4,2).   (3,1)(4,2).   (3,1)(4,2).   (3,5,4,2,1).
(4,1)(3,2).   (2,5,3,4,1).   (4,5,2,3,1).   (4,5,2,3,1).   (4,5,2,3,1).   (5,3,2,4,1).

K5*K4

(1,2,3,4,5)
(1,2,3)-(2,3,4)-(1,3,4)-(1,2,4)-(1,2,5)-(1,3,5)-(2,3,5)-(1,4,5)-(2,4,5)-(3,4,5)-
(3,4,2)-(1,4,3,2)-(4,3,2)-(4,2,1)-(5,3,2)-(5,2,1)-(5,4,1)-(5,4,2)-(5,4,3)-

(1,2)(3,4)-(1,3)(2,4)-(1,4)(2,3)-(1,2)(3,5)-(1,3)(2,5)-(1,5)(2,3)-(1,2)(4,5)-
(1,4)(2,5)-(1,5)(2,4)-(1,3)(4,5)-(1,5)(3,4)-(2,3)(4,5)-(2,4)(3,5)-(2,5)(3,4)-
(2,5)(3,4)-

GROUP (1,2,3,4,5)   K5*K4

(1,2,3)-   (1,2,3)-   (1,3,4)-   (1,2,4)-   (1,2,5)-   (1,3,5)-
(1,3)(2,4)-   (4,2,1)-   (4,3,2)-   (4,3,1)-   (4,3,1)-   (5,2)(4,3)-
(4,2,1)-   (3,2,1)-   (2,3,1)-   (2,3,1)-   (4,3,1)-   (4,2,5,3,1)-
(3,5,1)-   (5,2,1)-   (2,5,3,4,1)-   (4,2)(5,3)-   (4,2,5,3,1)-   (3,5,2)-
(5,2,1)-   (3,4,5,1)-   (3,4,2,1)-   (5,2,3,4,1)-   (5,3,1)-   (5,2,1)-
(3,5)(2,1)-   (5,1)(4,3)-   (5,1)(4,3)-   (5,1)(4,3)-   (3,2,1)-   (2,3,1)-
(5,2,3,4,1)-   (2,3,5,4,1)-   (3,5,2,4,1)-   (3,2,5,4,1)-   (4,5,2)-   (3,4,5,2,1)-
(4,2,3,5,1)-   (5,1)(3,2)-   (5,1)(3,2)-   (2,3,4,5,1)-   (5,2,1)-   (3,2,5,4,1)-
(2,5,3,4,1)-   (4,2,5,3,1)-   (4,2,5,3,1)-   (5,4,2)-   (4,2,1)-   (4,5,3,1)-
(3,1)(4,5)-   (2,5,3,4,1)-   (5,1)(3,2)-   (4,5,1)-   (2,5,4,3,1)-   (5,4,2)-
(4,2)(3,5)-   (4,2,3,5,1)-   (3,2,5,4,1)-   (3,5,4,2,1)-   (2,3,4,5,1)-   (5,4,1)-
(5,2)(4,3)-   (5,4,3)-   (5,4,3)-   (5,4,3)-   (3,2,4,5,1)-   (2,3,4,5,1)-
(5,2)(4,3)-   (4,1)(5,2)-   (4,1)(5,2)-   (4,1)(5,2)-   (4,1)(3,2)-   (4,3,2,5,1)-

(2,3,5)-   (2,3,4)-   (1,4,5)-   (2,4,5)-   (1,2,5)-   (1,3,5)-
(2,5,3,4,1)-   (3,2,1)-   (2,4,5,3,1)-   (3,4,1)-   (5,2)(4,3)-   (4,3,5,2,1)-
(3,5,4,2,1)-   (3,2,1)-   (2,4,5,3,1)-   (2,3,1)-   (4,2,5,3,1)-   (2,3,1)-
(5,2,1)-   (5,2,5,3,1)-   (4,3,2,1)-   (4,1)(5,3)-   (3,5,1)-   (4,2,5,3,1)-
(5,3,1)-   (4,1)(5,3)-   (4,1)(3,2)-   (4,3,5,2,1)-   (3,2,1)-   (5,1)(4,2)-
(3,5,1)-   (5,3,1)-   (4,1)(3,2)-   (4,5,3,1)-   (4,5,2)-   (4,3,5,2,1)-
(3,2,4,5,1)-   (2,4,5,3,1)-   (4,5,2)-   (2,4,1)-   (5,2,1)-   (4,3,5,2,1)-
(4,1)(3,2)-   (4,1)(5,2)-   (5,4,2)-   (4,5,2,3,1)-   (4,2,1)-   (3,2)(5,4)-
(5,4,2,3,1)-   (5,4,2,3,1)-   (4,5,1)-   (5,3,2,4,1)-   (2,5,4,3,1)-   (4,5,3,2,1)-
(4,1)(5,2)-   (4,1)(5,2)-   (3,5,4,2,1)-   (5,2,1)(4,3,1)- (2,3,4,5,1)- (5,1)(3,2)-
(4,5,3)-   (4,5,3)-   (2,1)(5,3)-   (3,4,5,2,1)-   (3,2,4,5,1)-   (3,2,5,4,1)-
(4,5,2)-   (4,3,2)-   (5,4,3)-   (2,1)(5,2)-   (4,1)(3,2)-   (5,4,3)-
(4,3,2)-   (3,4,2)-   (4,5,3)-   (3,4,2)-   (3,4,2)-   (5,4,3)-

(4,3,1)-   (4,3,1)-   (5,2,1)-   (5,2,1)-   (5,3,2)-   (5,4,1)-
(3,2,1)-   (2,3,5,4,1)-   (2,1)(4,3)-   (5,1)(4,3)-   (2,5,3,4,1)-   (5,3,4,2,1)-
(2,4,1)-   (3,4,1)-   (5,4,2,3,1)-   (4,5,2,3,1)-   (3,5,2,4,1)-   (5,2,4,3,1)-
(5,4,3,2,1)-   (3,2,5,4,1)-   (4,1)(5,3)-   (5,2,1)(4,1)- (2,1)(5,4)-   (5,1)(3,2)-
(4,2,3,5,1)-   (2,3,1)-   (3,5,1)-   (3,5,1)-   (2,3,1)-   (3,5,4,2,1)-
(5,4,3,2,1)-   (5,4,1)-   (3,2,1)-   (5,2,1)-   (5,2,1)-   (3,2,1)-
(5,4,2,3,1)-   (4,2,3,5,1)-   (4,5,2,3,1)-   (4,5,2,3,1)-   (4,5,2,3,1)-   (2,4,5,3,1)-
(5,4,1)-   (5,2,4,3,1)-   (5,3,2,4,1)-   (4,5,3,2,1)-   (5,3,2,4,1)-   (4,1)(5,3,2)-
(3,5,1)-   (5,4,2,3,1)-   (2,1)(5,3)-   (2,1)(5,3)-   (4,5,3,2,1)-   (3,2,5,4,1)-
(5,4,2,3,1)-   (3,2,1)-   (4,1)(5,3)-   (3,1)(4,2)-   (3,1)(4,2)-   (4,3,2,5,1)-
(4,5,3)-   (4,5,1)-   (5,3,2)-   (4,5,2)-   (4,2,3,5,1)-   (4,5,1)(3,2)-
(4,5,2)-   (3,4,2)-   (3,4,2)-   (3,4,2)-   (3,5,2)-   (2,5,3,4,1)-
(4,3,1)-   (5,3,2)-   (5,3,2)-   (4,5,2)-   (4,3)

(5,4,2)-
(2,5,3,4,1)-
(3,5,1)(5,2)-
(2,3,5,4,1)-
(2,5,3,4,1)-
(5,4,2,3,1)-
(5,4,3,2,1)-
(4,3,2,5,1)-
(3,1)(4,2)-
(4,5,1)-
(5,2,1)-
(3,4,2)-
(5,3,2)-
(4,5,3)-

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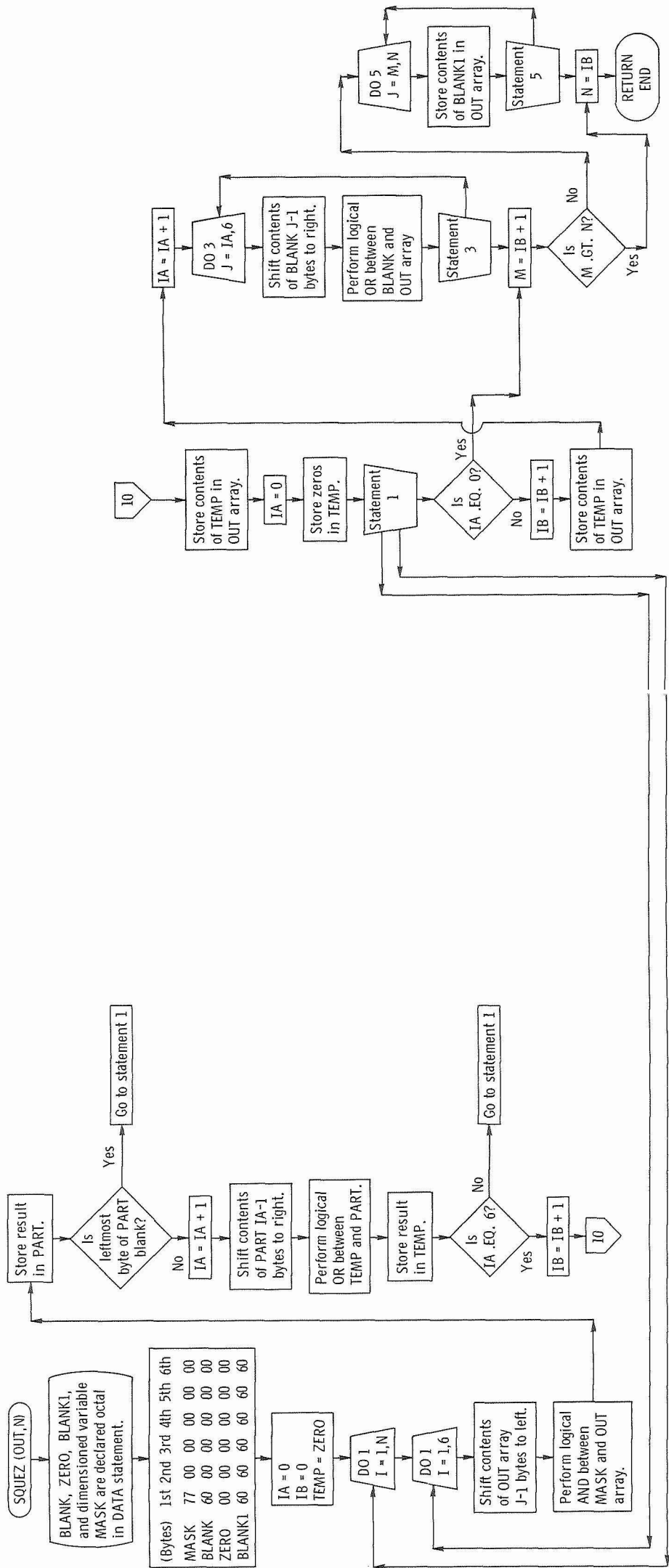
DO 5 J = M,N

Store contents of BLANK1 in OUT array.

Statement 5

N = IB

RETURN END

IA = IA + 1

DO 3 J = IA,6

Shift contents of BLANK J-1 bytes to right.

Perform logical OR between BLANK and OUT array

Statement 3

M = IB + 1

Is M .GT. N? No Yes

IO

Store contents of TEMP in OUT array.

IA = 0

Store zeros in TEMP.

Statement 1

Is IA .EQ. 0? Yes No

IB = IB + 1

Store contents of TEMP in OUT array.

Store result in PART.

Go to statement 1

Is leftmost byte of PART blank? Yes No

IA = IA + 1

Shift contents of PART IA-1 bytes to right.

Perform logical OR between TEMP and PART.

Store result in TEMP.

Is IA .EQ. 6? No Yes

Go to statement I

IB = IB + 1

IO

SQUEZ (OUT,N)

BLANK, ZERO, BLANK1, and dimensioned variable MASK are declared octal in DATA statement.

(Bytes)	1st	2nd	3rd	4th	5th	6th
MASK	77	00	00	00	00	00
BLANK	60	00	00	00	00	00
ZERO	00	00	00	00	00	60
BLANK1	60	60	60	60	60	60

IA = 0
IB = 0
TEMP = ZERO

DO 1 I = 1,N

DO 1 I = 1,6

Shift contents of OUT array J-1 bytes to left.

Perform logical AND between MASK and OUT array.

Figure 1. - Flowchart for subroutine SQUEZ.

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— NATIONAL AERONAUTICS AND SPACE ACT OF 1958

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